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*RESOURCE*
*MANUAL*

# USPOP

## UNITED STATES POPULATION STUDY

Developed by:

James Friedland, General Douglas MacArthur High School
Levittown, New York

Support Material By:

James Friedland

Programmed By:

James Friedland
Stuart Hollander, State University of New York
Stony Brook, New York

HUNTINGTON TWO COMPUTER PROJECT

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# *USPOP*

## RESOURCE MANUAL

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# I. WHY USE *USPOP*

The current growth rate of the world's population is about 2% per year; while this rate may seem small enough, the U. S. National Academy of Sciences has projected that if this growth rate had prevailed since the time of Christ, there would now be 100 persons per square foot of the earth's surface. Given today's larger population, a continuing growth rate of 2% per year would lead to the same unbelievable population densities in only a few centuries. Clearly, this rate of population growth cannot be maintained indefinitely.

This idea of a population threat was not well defined for the average person even ten years ago; today the population explosion is a deep and troubling concern for many grade school children. For this reason, an analytical approach to the problem of population growth and control is as important as it is appropriate in secondary education today.

In general, the teacher is as restricted in the study of population problems as the student. The problem of human population growth, when fully analyzed, is a highly complex mathematical phenomenon; not only are such obvious factors as birth rate and death rate important, but the sex ratio of offspring, time of first birth, and differential mortality also play a critical role. For example, while the United States is worrying about overpopulation, countries such as France worry about underpopulation. In the case of these two countries, the main difference lies in the age structures of their respective populations. In France about 30% of the population is over 50, so that a substantial number of women are past reproductive age. This results in fewer births per person and declining population.

With these ideas in mind, the HUNTINGTON TWO PROJECT embarked on the development of a human population model that could be used in the classroom and as an educational tool, as well as in the laboratory. *USPOP* is based on a model quite close to that used by U. S. Government demographers in their population projection work. Several simplifying assumptions had to be made since we were restricted in the degree of complexity we could achieve on a so-called minicomputer; but comparisons of *USPOP* and government projections indicate that errors due to these assumptions are relatively small.

*USPOP* has been developed primarily to provide the student with laboratory experiences, or to facilitate individualized learning about population factors. To this end, the *STUDENT MANUAL* contains suggested investigations. The Manual covers the effects of fertility, mortality, and birth distribution on both population size and age structure. All these investigations are basic in both approach and necessary student skills. More advanced investigations may be found in the *RESOURCE MANUAL*.

No teacher is likely to ask his or her students to carry out all five of the laboratory investigations. These have been included to allow the teacher to choose investigations that best complement the course of study, or to accommodate the teacher who feels it important to have each group of students tackle a unique problem.

Each investigation in the *STUDENT MANUAL* examines the effect of a single variable. The student is given an introductory reading that explains *USPOP* in general and his problem in particular. He is then given a suggested procedure that may be used to solve the problem. These suggestions are quite general, however, and depending on the skill of your class in biological investigation, you may decide to supplement them with additional instructions found in the *TEACHER MANUAL*. After completion of the investigation, the student is presented with several questions that can be used to evaluate his or her achievement. Sample answers to these questions are also supplied in the *TEACHER MANUAL*.

## II. BACKGROUNDS ON HUMAN POPULATION STUDY

### A. History of Demography

*Demography*, the study of populations, existed long as a discipline before it received its current name. In 1855, Builliard coined the term from the Greek word *"demos"* meaning people. Demography had its genesis in the very earliest census gathering. The need to know the size and nature of the population grew as government became more centralized. There is evidence to indicate that an extensive census was taken during the reign of King David (about 1000 B.C.), and both the Greeks and Romans clearly used census data in their planning.

The Romans were concerned with population planning to such an extent that they attempted to legislate an increase in birth rate by denying childless women the right to wear jewelry. It should be noted that they met with very little success.

Modern periodic census-taking started in the year 1666 with a Canadian census. With each passing year the mound of data has grown; had demography failed to make use of developing statistical techniques, census-taking would have soon become impossible. Demography was one of the first biological fields to make use of quantitative methods, and doing census work today is practically synonymous with computer technology, because of the vast amounts of information that have to be processed in order to administer to the complex needs of the population.

It is not enough to know what has taken place, however; it is often necessary to plan projects many years into the future. This need brought about a second phase of human demography -- population projection. Naturally, early projection techniques were crude. The Greeks attempted to model the growth of population considering such facts as birth and immigration versus mortality and emigration. By the late 1500's, certain Italian demographers had begun to study the role of environmental limitations. Today demographers have developed a complex set of variables to describe the behavior of population.

Compared with early population projections, today's work seems accurate indeed. Yet, for all the statistical information available, no definite answer as to future population is ever possible; there are always contingencies which cannot be predicted. For this reason, government demographers never make a single projection. Entire series of projections are made, with a different set of assumptions for each projection. In this way, the likelihood of having a projection which approximates reality is increased.

In any project many variables have to be evaluated. Some of the most important variables are fertility, birth distribution, sex ratio, and mortality. These four variables interact with a fifth: age distribution.

## B. Fertility

Fertility can be thought of as the number of live births the average woman can be expected to have over her entire reproductive life span. This term is more biologically precise than birthrate (which is in units of births per 1000 population), because it is unaffected either by the sex or age distribution of the population.

Fertility varies from country to country and from time to time. Underdeveloped countries tend to have high fertility, as well as high mortality rates; fertility as high as 6-10 children per female is not at all uncommon. Industrialized countries, on the other hand, have both lower fertility and lower mortality rates. Fertility in industrialized countries is generally between 2.0 and 4.0.

Fertility in the United States has varied greatly over the past 50 years, as shown in the chart below. Variations in fertility have been correlated with both the social and economic conditions in the country.

| Year | Fertility (children per female) |
|---|---|
| 1920 | 3.3 |
| 1925 | 3.0 |
| 1930 | 2.5 |
| 1935 | 2.2 |
| 1940 | 2.3 |
| 1945 | 2.5 |
| 1950 | 3.1 |
| 1955 | 3.6 |
| 1960 | 3.7 |
| 1965 | 2.9 |
| 1970 | 2.45 |
| 1972 | 2.1 estimated |

During the depression in the 1930's, fertility was low and this low pattern continued throughout World War II. Starting in the late 40's and early 50's, fertility has shown the effects of the post-war baby boom. Fertility continued to grow throughout the 50's into the early 60's as former servicemen continued to expand their families. By the late 60's, however, these families passed out of the reproductive pool and fertility again decreased.

Others have tried to explain this fertility shift in economic terms. The 30's and the war years were periods of economic uncertainty as well as low fertility. While many economists predicted serious economic troubles for the United States in the post-war years because of the problems of adjusting to a peace-time economy, the problems never developed. The 1950's were a time of great economic growth; fertility and average family size also grew throughout this period. Starting with the 70's, the economy again became uncertain, and at this time fertility again showed a dip.

Fertility today is currently at a level very near that recorded during the midst of the depression. Opinion as to why this should be so is divided. Some see this change as a permanent shift in attitude about family size in women entering the reproductive pool, while others interpret this drop in fertility as an effect of an uncertain economy, saying that fertility has dropped because many women are delaying their families. In either case, the next few years should tell if fertility will remain low or swing upward again.

### C. Birth Distribution

*When* children are born to a woman is often as important as the number of children. Since we used the term fertility to describe the average number of offspring, we may describe birth distribution in terms of the fraction of fertility expressed for each year of the woman's reproductive period.

Just as fertility has varied in the United States' recent history, so has birth distribution.

TABLE 2 - PER CENT FERTILITY IN EACH 5-YEAR PERIOD

| A G E | 1970 | 1965 | 1960 | 1955 | 1950 | 1945 | 1940 |
|---|---|---|---|---|---|---|---|
| 10-14 | .2 | .2 | .1 | .1 | .1 | .2 | .1 |
| 15-19 | 14.3 | 12.6 | 12.4 | 12.8 | 13.0 | 10.2 | 11.8 |
| 20-24 | 33.8 | 33.2 | 35.2 | 33.6 | 31.8 | 27.9 | 29.5 |
| 25-29 | 28.5 | 27.6 | 26.9 | 26.6 | 27.2 | 26.5 | 26.7 |
| 30-34 | 14.7 | 16.2 | 15.4 | 16.3 | 16.7 | 20.1 | 18.1 |
| 35-39 | 6.6 | 7.9 | 7.8 | 8.3 | 8.6 | 11.5 | 10.0 |
| 40-44 | 1.8 | 2.2 | 2.1 | 2.2 | 2.4 | 3.3 | 3.4 |
| 45-49 | .1 | .1 | .1 | .1 | .2 | .3 | .4 |

This chart shows that women today are having their children earlier. There appear to be two reasons for this effect. First, women today are having fewer children, so we would naturally expect a greater percentage of their offspring to be born during these women's earlier reproductive years. Secondly, there is the effect of World War II. Women who would ordinarily have had their children during the war years delayed their families, so that their children were born at a later time in their lives. If these two effects are taken into account, no real shifts in birth distribution can be found for recent years.

When we view birth distribution around the world, however, we find many real differences. In countries such as India, a sizable portion of the females are married in their very early teens and have their first child before they are 15 years of age. Other countries have a tradition of delayed fertility. The classical example is Ireland, where custom has delayed marriage and first children to the late 20's and early 30's.

Even if fertility were to remain constant, a change in birth distribution would result in a change in population growth. This avenue of population control has been advocated for countries with severe population problems, but it is probably doomed to failure since it often means the changing of ingrained social and religious patterns.

### D. Sex Ratio of Offspring

More males are born than females. The sex ratio today is about 51.5% male births to 48.5% female. Why is this so?

In spite of the fact that according to Mendelian Laws there should be an equal chance of a male and female being conceived, there is good proof that this is not the case. Estimates made from the examination of spontaneous abortions (miscarriages) indicate that up to 170 males are conceived for every 100 females. While this estimate is probably too high, no estimates place the ratio near 50-50.

Reasons for this surplus production of males are as numerous as they are uncertain. This being the case, one can have a good deal of fun speculating without fear of being contradicted. Some biologists have maintained that males are conceived more often because the sperm carrying the Y chromosome is lighter than the sperm carrying the X chromosome and is, therefore, more likely to reach the egg cell.

Others have sought to explain this phenomenon in evolutionary terms. Some of this reasoning rests on the biological fact that the male fetus is less strong than his female counterpart. If in the past, the argument goes, living conditions were much less favorable, especially for the pregnant female, intrauterine conditions must also have been poor. Such a state would naturally favor the production of females. Since a balanced production of males and females would seem to be biologically favorable, natural selection would favor those groups of pre-humans that had had a tendency to produce a surplus of male conceptions. If this biological trend were continued to the present day when prenatal conditions have been vastly improved, a surplus of males would be born.

Many other interesting phenomena have been associated with sex-ratio differences. It has been noted that males occur in a higher percentage of first births and decline in majority with an increase in the mother's age. Scientists have used the argument about prenatal conditions to explain this, saying that there is a more hostile intrauterine environment in women of older age, a condition that favors the female fetus. Also, increases in male births have been recorded during wartime, a phenomenon that is a good deal harder to explain.

A frequently cited cause of sex-ratio difference is race. It now appears that these differences are not real, but a result of under-registration of female births by racial minorities.

Challenge your students to think of other reasons why more males might be born than females. It could be a very interesting way to review both evolution and reproduction!

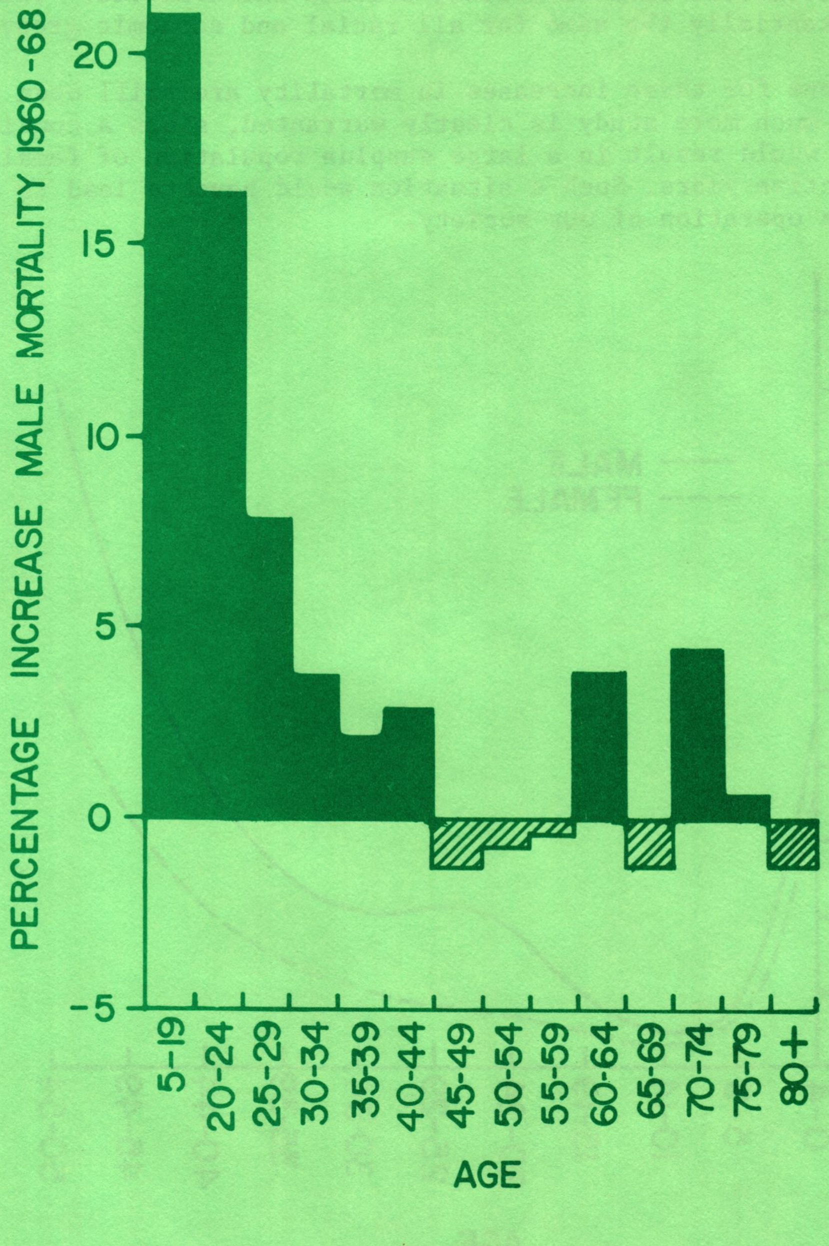
## E. Mortality

Two disturbing facts have recently become evident concerning mortality in the United States. First, infant mortality in the U. S. is relatively high when compared with mortality in other advanced nations. Secondly, the U. S. is one of three nations in the entire world in which male life expectancy has actually fallen in the last 10 years.

At the present time the United States ranks 14th in infant mortality. This is a shocking figure, especially for a country that prides itself on being the most advanced technologically. The general infant mortality rate is approximately 28 deaths per 1000 live births. If you are a member of the lower class or an ethnic minority, things are even worse: infant mortality rises to 33 deaths per 1000 live births in these groups. Are there any biological factors that would explain this high rate? The answer is apparently no. Infant mortality for the upper-income brackets, where expensive prenatal care and counseling can be afforded, is only 17 per 1000 births. This would seem to indicate that the problem is not biological, but social.

Recently there have been attempts in the United States to come to grips with this problem. The March of Dimes is currently advertising through the media to make women aware of the importance of prenatal medical care. But there is considerable doubt that the U. S. has the necessary personnel or facilities for all women to have the necessary prenatal care required to lower our infant mortality to a more acceptable level.

The problem of increased male mortality is more complex. After a steadily increasing rise in life expectancy throughout the 20th century, the United States has for the first time seen a drop in life expectancy among its male population, while females have continued to increase their life expectancy over the last 10 years. (See GRAPH 1 below.)



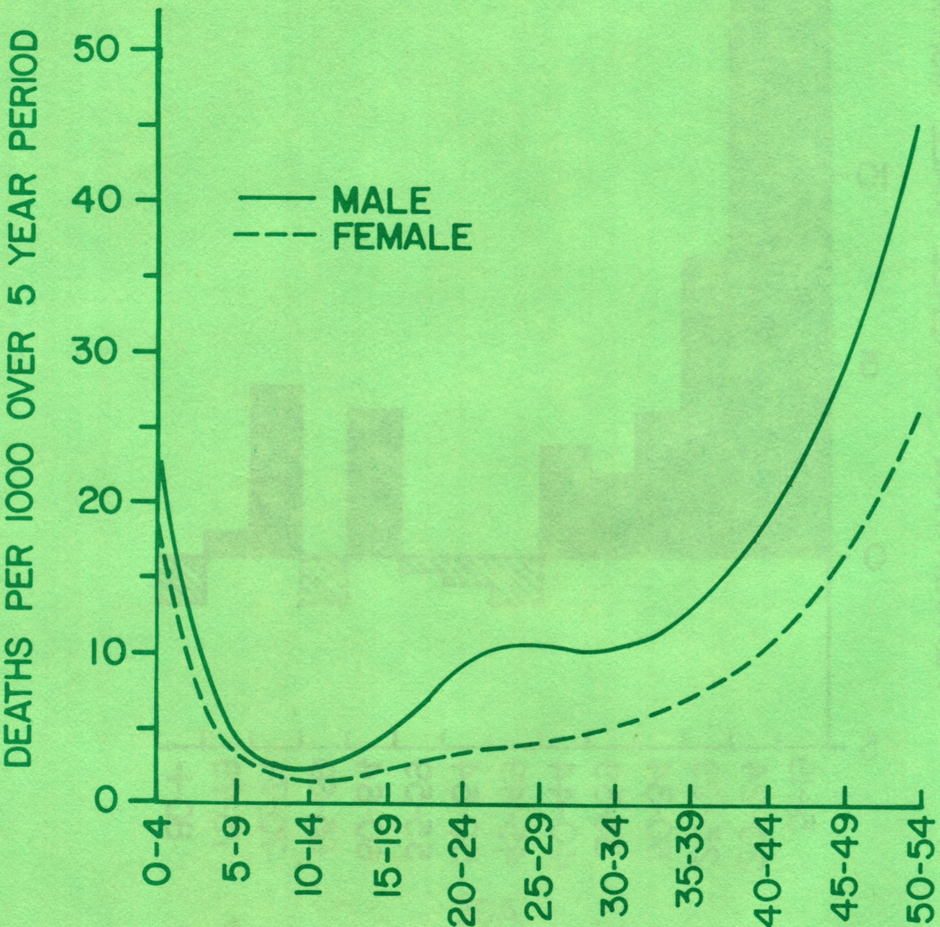
GRAPH 1

What has caused this increase in male mortality? The United States has just completed a statistical survey to answer this question.* For those males over 30 there has been a sizable increase in the incidence of fatal lung cancer and other smoking-related diseases (such as emphysema) over the past 10 years. Among males in their late teens and early twenties the marked increases in mortality over the past 10 years have largely been a result of automobile-related deaths, suicide and homicide. This pattern has been substantially the same for all racial and economic groups.

---

* "Leading Components of Upturn in Mortality for Men," DHEW Publication No.(HSM) 72-1008. (The Department of Health, Education and Welfare's document is available for 50¢ from the U.S. Government Printing Office.)

The reasons for these increases in mortality are still open to controversy, but much more study is clearly warranted, since a continuation of this trend would result in a large surplus population of females in their reproductive years. Such a situation would have to lead to drastic changes in the operation of our society.



GRAPH 2

GRAPH 2 shows mortality/1000 versus age for both males and females. Two things to notice are (1) that females always have lower mortality, and (2) the especially high mortality for males in their 20's.

### F. Age Distribution

As mentioned earlier, all the other factors: fertility, birth distribution, sex ratio and mortality tend to influence the age structure of the population. In the United States today, the age structure is such that the median age is approximately 28 years. News media have often estimated a lower number when discussing the "youth revolution," but the fact remains that those over 30 are in the minority.

Countries with high birth rates and high mortality tend to have very young populations, while countries with low birth rates and low mortality have uniformly distributed or old-age-dominant distributions. This observation has led to the concept of *demographic transition*, a process wherein falling mortality rates unaccompanied by falling birth rates produce a population explosion, with the birth rate declining only 100 years later. European countries underwent demographic transition during the 19th century. The surplus population produced during this process had a "safety valve" for expansion: namely, the North and South American continents.

Today, many countries are undergoing a similar demographic transition. This transition is producing even larger increases in population (from 2-3% per year), and there is no safety valve for expansion. The consequence is tremendous overcrowding and depletion of resources necessary for successful completion of this transition.

## III. RUNNING *USPOP*

### A. Explanation of Program Inputs

Due to the exceedingly large amount of information needed for the *USPOP* model, operational shortcuts were designed into the program. Instead of requiring the student to input over 80 numbers, the program stores (in DATA statements) the latest available statistics describing the U. S. population in 1970. The student should be encouraged to make maximum use of these statistics, as this will save him a great deal of time.

Should the student desire to use other variable values, the program allows him to try numerous values for all the variables. Variable values may also be changed during a RUN (by requesting a Number 4 Report).

What follows is an elaboration of the computer instructions given in the *STUDENT MANUAL*:

#1 DO YOU WANT REPORTS (1) EVERY 5-YEAR INTERVAL OR (2) SELECTED YEARS?

Typing a "2" will enable the student to save a great deal of time in the case of a long-term projection.

#2 YEAR AT START OF PROJECTION?

If the student is going to make extensive use of the data stored in the program, he should type "1970". If he is using data collected for another year, that year number should be typed.

#3 DO YOU ASSUME STANDARD FERTILITY (1=YES, 0=NO)?

This is a yes/no answer (1=yes, and 0=no). If the student types "1", the computer will read the fertility from the 1970 data and skip to question #5.

If the answer was "no" (0), the computer will ask:

#4 FERTILITY IN YEAR _____?

The year number entered in #2 above should appear in the blank.

#5 WILL FERTILITY (1) STAY CONSTANT OR (2) CHANGE SLOWLY TO A NEW LEVEL?

The student enters the number that best represents the assumption he wishes to explore. If he selects "1", the computer will skip to question #8.

If the answer was "2":

#6 WHAT FERTILITY WILL BE STABLE?

Student types fertility that he assumes will eventually stay constant. (NOTE: at a later time in the RUN, this assumption may be changed.)

#7 HOW MANY DECADES BEFORE FERTILITY REACHES STABILITY?

After the student answers Questions #6 and #7, the computer will have evaluated all factors related to total fertility.

#8 DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES, 0=NO)?

This is also a yes/no answer. If the student types "1", 1970 data will be read from storage and the program will skip to question #10.

If the student typed "no" (0):

```
#9   PER CENT OF FERTILITY OCCURRING IN FEMALES AGES:
     10-14?
     15-19?
     .. ..
     45-49?
```

Student responds to these questions according to the situations he wishes to explore. The total for percentages must add to 100. After computer checks addition, program proceeds to question #10.

```
#10  DO YOU ASSUME STANDARD MORTALITY (1=YES, 0=NO)?
```

Again this is a yes (1) — no (0) question. If student types "1", 36 pieces of 1970 mortality data are read from the program. If he types "0", he may modify some or all of the male and female mortalities.

If the student types "1", the program skips to question #13.

Otherwise:

```
#11  CHANGE IN MORTALITY OCCURRING IN FEMALES (FROM AGE, TO AGE)?
```

Student sets lower and upper limits for range of age groups for which he wants to change mortality. For example, if he wants to change all mortalities, he should type "0,75". If the student does not wish to change the mortality rate for any female age group, he should type "0,0".

The computer then responds with:

```
GROUP          CURRENT      NEW VALUE
             DEATH/1000

 0-4             17.8           ?
 5-9              2.8           ?
10-14             1.5           ?
15-19             2.2           ?
.                 .             .
.                 .             .
75 & older      337.3           ?
```

Following each question mark the student should enter the new value of mortality for that age group.

#12 CHANGE IN PER CENT MORTALITY OCCURRING IN MALES (FROM AGE, TO AGE)?

Exactly the same procedure as above, except that male mortality is now considered. Typing "0,0" will result in no change.

#13 DO YOU ASSUME STANDARD POPULATIONS (1=YES, 0=NO)?

Yes/no question (1=yes, 0=no). If student types "1", the population is set equal to the 1970 population and computer skips to #16.

If student answers "no" (0):

#14 POPULATION CHANGE IN FEMALE GROUPS (FROM AGE, TO AGE)?

If student wishes to change the size of all population cohorts, he would type "0,75". Should he want to make changes for only one or two age groups, leaving the rest at 1970 values, he might type "20,29", for example.

The computer would respond with:

```
GROUP                  CURRENT        NEW VALUE
               POPULATION MILLIONS

20-24                    8.5             ?
25-29                    6.9             ?
```

The student would then enter new values for the appropriate cohort populations in millions (decimal numbers allowed).

#15 POPULATION CHANGE IN MALE GROUPS (FROM AGE, TO AGE)?

Same procedure as for #14.

#16 REPORT: 1) SHORT 2) LONG 3) GRAPH 4) CHANGE ASSUMPTIONS 5) END?

Student can select any output format that he requires (for examples see Sample Runs included), obtain an option to change any variable values, or conclude the RUN by typing the appropriate number.

The computer will then carry out all mathematics and issue a report in the proper format, if a report is requested. After this, the computer will return to question #16 for further instructions.

B. Additional Sample Runs (for more examples see *USPOP TEACHER MANUAL*)

In the Sample Run below, a student is carrying out a projection in which he has altered birth-distribution assumptions. This facet of demography is studied in Investigation #2 in the *STUDENT MANUAL*.

```
DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL
OR 2) SELECTED YEARS ?1

YEAR AT START OF PROJECTION ?1970

DO YOU ASSUME STANDARD FERTILITY (1=YES,0=N0) ?1
WILL FERTILITY (1) STAY AT 2.45  OR (2) CHANGE SLOWLY
TO A NEW LEVEL ?1

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO) ?0
PCT. FERTILITY OCCURING IN FEMALES AGES:
 10 - 14  ?30
 15 - 19  ?40
 20 - 24  ?30
 25 - 29  ?0
 30 - 34  ?0
 35 - 39  ?0
 40 - 44  ?0
 45 AND OLDER ?0

DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO) ?1

DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO) ?1

REPORT:1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END ?1

YEAR 1970     POP=  204.8  MILLION          FERTILITY 2.45

REPORT: ?1

YEAR 1975     POP=  218.9  MILLION          FERTILITY 2.45

REPORT: ?1

YEAR 1980     POP=  233.9  MILLION          FERTILITY 2.45

REPORT: ?1

YEAR 1985     POP=  247.5  MILLION          FERTILITY 2.45
```

```
REPORT: ?1

YEAR 1990      POP=  261  MILLION             FERTILITY 2.45

REPORT: ?1

YEAR 1995      POP=  275.9  MILLION           FERTILITY 2.45

REPORT: ?1

YEAR 2000      POP=  292.4  MILLION           FERTILITY 2.45

REPORT: ?5

ANOTHER PROJECTION (1=YES, 0=NO) ?0
```

In the following **RUN**, the student is investigating the effect of a slowly lowering fertility. Note the effect on the reports.

```
DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL
OR 2) SELECTED YEARS ?2
```

*BY TYPING "2" THE STUDENT MAY SKIP REPORTS.*

```
YEAR AT START OF PROJECTION ?1975

DO YOU ASSUME STANDARD FERTILITY (1=YES,0=NO) ?0
FERTILITY IN 1975  ?2.06
WILL FERTILITY (1) STAY AT 2.06  OR (2) CHANGE SLOWLY
TO A NEW LEVEL ?2
```

*CHOICE "2" MAKES SLOW SHIFTS IN FERTILITY POSSIBLE WITHOUT INTERRUPTING THE PROGRAM. FERTILITY WILL SLOWLY DROP TO 1 AND THEN REMAIN AT THAT LEVEL.*

```
WHAT FERTILITY WILL BE STABLE ?1
HOW MANY DECADES UNTIL FERTILITY REACHES 1  ?3.5

DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO) ?0
PCT. FERTILITY OCCURING IN FEMALES AGES:
 10 - 14  ?.5
 15 - 19  ?20
 20 - 24  ?40
 25 - 29  ?20
 30 - 34  ?10
 35 - 39  ?5
 40 - 44  ?4.5
 45 AND OLDER ?0

DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO) ?0
PERCENT FEMALE BIRTHS ?30
```

*STUDENT HAS CHANGED THE BIRTH SEX RATIO SO 30% OF ALL LIVE BIRTHS ARE FEMALE AND 70% ARE MALE.*

```
DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO) ?0
CHANGE IN MORTALITY OCCURING IN FEMALES
GROUPS (FROM AGE, TO AGE) ?0,4
GROUP              CURRENT          NEW VALUE
                   DEATH/1000
 0 - 4              17.8             ?10
CHANGE IN MORTALITY OCCURING IN MALES
GROUPS (FROM AGE, TO AGE) ?0,4
GROUP              CURRENT          NEW VALUE
                   DEATH/1000
 0 - 4              22.5             ?14

DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO) ?0
```

*TYPING "0" ALLOWS CHANGES IN STARTING YEAR POPULATION.*

```
CHANGE IN FEMALE POPULATION
GROUPS (FROM AGE, TO AGE) ?0,0
```

*"0,0" MEANS NO CHANGES*

```
CHANGE IN MALE POPULATION
GROUPS (FROM AGE, TO AGE) ?15,34
GROUP              CURRENT          NEW VALUE
          POPULATION MILLIONS
 15 - 19            9.8              ?8
 20 - 24            8.6              ?4.3
 25 - 29            6.8              ?3.4
 30 - 34            5.7              ?2.8
```

*OLD POPULATION IS GIVEN, THEN STUDENT IS ASKED FOR NEW FIGURE. ALL VALUES ARE IN MILLIONS. <u>EXAMPLE:</u> 3.4 MEANS 3,400,000.*

```
REPORT:1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END ?2

YEAR 1975      POP=  192.4  MILLION           FERTILITY 2.06
 AGES     FEMALES <-MILLIONS-> MALES           PCT. TOTAL
 0 - 4              8.4              8.7          8.9
 5 - 9              9.7              10.1         10.3
 10 - 14            10.2             10.5         10.8
 15 - 19            9.4              8            9
 20 - 24            8.5              4.3          6.6
 25 - 29            6.9              3.3          5.3
 30 - 34            5.8              2.7          4.4
 35 - 39            5.7              5.5          5.8
 40 - 44            6.1              5.8          6.1
 45 - 49            6.2              5.9          6.3
 50 - 54            5.7              5.3          5.7
 55 - 59            5.2              4.7          5.1
 60 - 64            4.6              4            4.5
 65 - 69            3.7              3            3.5
 70 - 74            3.2              2.3          2.9
 75 AND OVER        4.6              2.9          3.9
```

IF REPORTS ARE TO BE GIVEN IN SELECTED YEARS:

*AT THE END OF EACH REPORT THE COMPUTER ASKS FOR THE YEAR OF NEXT REPORT. ANY "FUTURE" YEAR MAY BE TYPED, BUT THE COMPUTER CAN ONLY RESPOND WITH AN INCREMENT OF 5 FROM THE STARTING YEAR.*

```
YEAR FOR NEXT REPORT ?1985
```

*NOTE THE GRADUAL FALL IN FERTILITY*

```
REPORT: ?1

YEAR 1985      POP=  206.9  MILLION          FERTILITY 1.75714
YEAR FOR NEXT REPORT ?1995

REPORT: ?1

YEAR 1995      POP=  218.1  MILLION          FERTILITY 1.45429
YEAR FOR NEXT REPORT ?2005

REPORT: ?1

YEAR 2005      POP=  216.9  MILLION          FERTILITY 1.15143
YEAR FOR NEXT REPORT ?2015

REPORT: ?2

YEAR 2015      POP=  207.3  MILLION          FERTILITY 1.


  AGES     FEMALES <-MILLIONS-> MALES          PCT. TOTAL
  0 - 4          1.7           3.9             2.7
  5 - 9          2.1           4.7             3.3
  10 - 14        2.7           6.1             4.2
  15 - 19        3.8           8.4             5.9
  20 - 24        4.8           10.4            7.3
  25 - 29        5.3           11.4            8.1
  30 - 34        5.4           11.6            8.2
  35 - 39        5.2           11              7.8
  40 - 44        8.8           8.8             8.5
  45 - 49        9.9           9.7             9.5
  50 - 54        10            9.7             9.5
  55 - 59        8.9           6.9             7.6
  60 - 64        7.6           3.4             5.3
  65 - 69        5.7           2.3             3.8
  70 - 74        4.2           1.4             2.7
  75 AND OVER    5.6           4.1             4.7
```

```
YEAR FOR NEXT REPORT ?2025

REPORT: ?1

YEAR 2025      POP=  191.3  MILLION         FERTILITY 1.
YEAR FOR NEXT REPORT ?2035

REPORT: ?1

YEAR 2035      POP=  168.1  MILLION         FERTILITY 1.
YEAR FOR NEXT REPORT ?2045

REPORT: ?1

YEAR 2045      POP=  140.8  MILLION         FERTILITY 1.
YEAR FOR NEXT REPORT ?2055

REPORT: ?1

YEAR 2055      POP=  116  MILLION           FERTILITY 1.


YEAR FOR NEXT REPORT ?2300

REPORT: ?2
```

*SELECTED YEAR OPTION ALLOWS STUDENT TO EXAMINE LARGE TIME INTERVAL.*

```
YEAR 2300      POP=  31.4  MILLION          FERTILITY 1.
 AGES     FEMALES <-MILLIONS-> MALES         PCT. TOTAL
 0 - 4          0.2            0.6           3
 5 - 9          0.4            0.7           3.7
 10 - 14        0.5            0.8           4.4
 15 - 19        0.6            1             5.2
 20 - 24        0.7            1.1           5.9
 25 - 29        0.8            1.2           6.5
 30 - 34        0.9            1.3           7.2
 35 - 39        0.9            1.3           7.4
 40 - 44        1              1.3           7.5
 45 - 49        1              1.3           7.5
 50 - 54        1              1.3           7.5
 55 - 59        1              1.2           7.3
 60 - 64        1              1.1           6.9
 65 - 69        0.9            0.9           6.1
 70 - 74        0.8            0.7           5
 75 AND OVER    1.5            1             8.2

YEAR FOR NEXT REPORT ?3000

REPORT: ?5

ANOTHER PROJECTION (1=YES, 0=NO) ?0
```

*TO END PROJECTION, IT IS STILL NECESSARY TO SET A DATE FOR NEXT REPORT.*

# IV. The *USPOP* MODEL

## A. About the Model

*USPOP* can be used to model any human population. In the course of developing the program, we made certain simplifying assumptions in order to reduce the size of the program and make it usable on smaller computers. As it stands, *USPOP* makes use of over 80 variables to delineate population behavior characteristics; if the model were more sophisticated, even more variables would be required to describe the population's characteristics.

The assumptions under which *USPOP* operates will not affect the model's performance to any noticeable extent if the population being modeled is sufficiently large; for a smaller population (under 500,000), however, some deviation may occur.

Clearly, in a model of a large population, each person cannot be depicted individually and assigned a unique set of variables for descriptive purposes. The individuals within a population are always placed into similar groups called cohorts. Closeness of age is one of the prime characteristics of a cohort; in addition, cohorts are often defined by sex. Very simple population models consider the population to be composed of either one or two cohorts. (This was the case in the HUNTINGTON TWO simulation *POP*.) The *USPOP* model considers the population to be composed of 32 cohorts, 16 of either sex. Each cohort is composed of those born in a contiguous 5-year period; therefore, the cohorts cover ages 0 to 4, 5 to 9, 10 to 14.....and 70 to 75. All members of a particular cohort share the general characteristics of the group, as specified in its set of variable values. Naturally this procedure simplifies the calculations involved in making the projection.

The calculations can be made still easier if we are content to look at the population only at 5-year intervals. By doing so, we can view each cohort as "graduating" together into the next age category. Of course, we do incur some error in doing this, but if the population is large enough, the error is usually so small that a 5-year calculating period is not objectionable. (Should you attempt to model a small population, however, you might detect deviations.)

## Other Applications of the *USPOP* Model

Although this program was done with U. S. data, it is a general human population model and may be applied to any population -- provided the following statistical information about the population can either be gathered or estimated:

1) Fertility - average number of live births per woman over her reproductive lifetime. For those women still in the reproductive ages, estimates must be made for the number of children they are likely to have. Note that non-reproductive women must also be considered in estimating the fertility.

2) Birth distribution - per cent of total fertility expressed by females of each age category. Estimates of this may be obtained from interviews or from relevant hospital records.

3) Sex ratio of offspring - per cent of live births: female and/or male.

4) Mortality rates - deaths per 1000 individuals in a single cohort over a 5-year period. These will be difficult to obtain. You may elect to use the same figures published for the country as a whole.

5) Populations of each cohort at beginning year. These can be obtained from any census taken for the area which you are modeling.*

Specific Suggestions

- Have your students attempt to obtain the above information for your community; then have them use *USPOP* to project the population of their community into the future. Discuss what these changes could mean to the community and to them personally. (*USPOP* assumes a net immigration of 400,000 individuals per year. To eliminate this, see Part F of Section IV.)

- Run comparative population projections for several countries. Data should be available through the World Health Organization of the United Nations. Have your students write both to WHO and embassies of countries that they are interested in to ask for the above information.

## B. *USPOP* Model Formulas

1) Total population:

$$P_t = \sum_{i=1}^{16} (M_i + F_i)$$

where $M_i$ equals the ith cohort of males and $F_i$ the ith cohort of females. (Each cohort represents a group born within a 5-year period.) $P_t$ equals the total population at time t. This assumes immigration is constant at 400,000 per year. $M_{16}$ and $F_{16}$ include all those age 75 and over.

---

*See references for sources in your area.

2) Births in the population:

$$B = f \sum_{i=3}^{10} (D_i \times F_i)$$

where f equals the total fertility, and $D_i$ the per cent fertility expressed by the ith female cohort. The limiting values of i assume that all births occur to females between the ages of 10-49. Also no direct male influence on births is assumed, as no M factor is used.

a) Male births:

$$M_o = mB$$

where m equals per cent of all male births.

b) Female births:

$$F_o = B-M_o$$

3) Fertility determination:

$$f = (f_1 + f_2) / 2$$

Fertility over the 5-year calculating period is assumed to be equal to the mean average of fertility at the beginning of the period ($f_1$) and fertility at the end of the period ($f_2$).

4) Mortality:

$$M_{i+1} = M_i \times T_{i+1}$$

$$i = 1, 2, \ldots 14$$

$$F_{i+1} = F_i \times S_{i+1}$$

Number surviving 5-year period ($M_{i+1}$ and $F_{i+1}$) assumed equal to original number ($M_i$ or $F_i$) times the probability of survival until the next 5-year interval ($T_{i+1}$ or $S_{i+1}$), except for the last age category (i=16), where

$$M_{16} = M_{16}T_{16} + M_{15}T_{16}$$

$$F_{16} = F_{16}S_{16} + F_{15}S_{16}$$

These equations assume that all those over age 70 have equivalent mortality rates.

## C. Additional Considerations and Assumptions

1) Populations should be large enough so that random fluctuations in size should be negligibly small by comparison.

2) Birth distribution, sex ratio and mortality rates are assumed to be constants for a particular run, although they may be altered through the course of many runs as the student wishes.

3) As noted before, it is assumed that males play no direct role in determining the number of births. If student desires to simulate such phenomena as war or an increase in a sex-related disease such as lung cancer, he must lower not only the number of males in the affected cohorts but the female fertility as well, assuming that a decrease in the number of males will affect female fertility.

4) All major descriptive population variables are assumed to be independent of each other. While this detracts from the realism of the model, it does make it easier for anyone using the program for studying population to determine cause and effect between variables.

5) All cohorts are assumed to be internally homogeneous; thus they may be represented by a single set of constants.

6) Age distribution within a cohort is assumed to be uniform.

7) Immigration represents net immigration. The age distribution of immigrants will stay near 1970 levels and there are equal numbers of each sex.

8) All standard figures are based on data from the Bureau of Census, Current Population Reports, Series P-25, No.493, and Bureau of Census, Statistical Abstracts of the United States, 1972. (See Reference Section for details.)

## D. *USPOP* LISTING

```
100 REM USPOP - US POPULATION PROJECTION SIMULATION
105 REM COPYRIGHT 1973 STATE UNIVERSITY OF NEW YORK
110 REM DEVELOPED BY J. FRIEDLAND
115 REM PROGRAMMMED BY J. FRIEDLAND, S. HOLLANDER
120 REM LATEST REVISION: JULY 30,1973
125 RESTORE
130 DIMB(10),M(4,16)
135 READY1,F2,J,T,F,I9,R9
140 DATA 0,0,0,0,0,0,0
145 READ B2
150 FORN=3TO10
155 READ B(N)
160 NEXTN
165 READM
170 FORN=1TO4
175 FOR N1=1TO16
180 READ M(N,N1)
185 NEXTN1
190 NEXTN
195 PRINT"DO YOU WANT REPORTS 1) EVERY 5 YEAR INTERVAL"
200 PRINT"OR 2) SELECTED YEARS";
205 INPUT F1
210 IF (F1-1)*(F1-2)<>0 THEN 195
215 PRINT
220 PRINT"YEAR AT START OF PROJECTION";
225 INPUTY2
230 PRINT
235 PRINT"DO YOU ASSUME STANDARD FERTILITY (1=YES,0=N0)";
240 INPUTQ
245 IFQ*(Q-1)<>0THEN235
250 GOSUB880
255 PRINT
260 PRINT"DO YOU ASSUME STANDARD BIRTH DISTRIBUTION (1=YES,0=NO)";
265 INPUTQ
270 IFQ=1THEN285
275 IFQ<>0THEN260
280 GOSUB1010
285 PRINT
290 PRINT"DO YOU ASSUME STANDARD SEX RATIO (1=YES,0=NO)";
295 INPUTQ
300 IFQ=1THEN315
305 IFQ<>0THEN290
310 GOSUB 985
```

```
315 PRINT
320 PRINT"DO YOU ASSUME STANDARD MORTALITY (1=YES,0=NO)";
325 INPUTQ
330 IFQ=1THEN345
335 IFQ<>0THEN320
340 GOSUB1085
345 PRINT
350 PRINT"DO YOU ASSUME STANDARD POPULATION (1=YES,0=NO)";
355 INPUTQ
360 IFQ=1THEN375
365 IFQ<>0THEN350
370 GOSUB 1120
375 FOR N=1TO16
380 LETT=T+M(1,N)+M(2,N)
385 NEXTN
390 IF F=1 THEN 455
395 PRINT
400 PRINT"REPORT:";
405 IFY1=0THEN415
410 GOTO420
415 PRINT"1)SHORT 2)LONG 3)GRAPH 4)CHANGE ASSUMPTIONS 5)END";
420 INPUTR
425 LET F=1
430 IF(R-1)*(R-2)*(R-3)*(R-4)*(R-5)<>0THEN415
435 IFR=5THEN1410
440 IFR<4THEN455
445 GOSUB805
450 GOTO395
455 IFY1=0THEN625
460 IFZ=1THEN495
465 IFF2=1THEN490
470 IFY3>=Y1THEN480
475 LETJ=0
480 LETB2=B2+J
485 GOTO495
490 LET F2=0
495 LETB=(B2+B1)/2
500 LETQ=0
505 FORN=3TO10
510 LETQ=Q+B*M(1,N)*B(N)
515 NEXTN
520 LETQ=Q+174845
525 LETI9=2667
530 LETM(2,16)=M(4,16)*(M(2,16)+M(2,15)+I9)
535 LETM(1,16)=M(3,16)*(M(1,16)+M(2,15)+I9)
540 LETT=M(2,16)+M(1,16)
```

```
545 FORN=0TO13
550 IFN>1THEN565
555 LETI9=2667
560 GOTO 585
565 IFN>7THEN580
570 LETI9=35100
575 GOTO585
580 LETI9=116200
585 LET M(2,15-N)=M(4,15-N)*(M(2,14-N)+I9)
590 LET M(1,15-N)=M(3,15-N)*(M(1,14-N)+I9)
595 LETT=T+M(2,15-N)+M(1,15-N)
600 NEXTN
605 LETM(2,1)=M*Q*M(4,1)
610 LETM(1,1)=(1-M)*Q*M(3,1)
615 LETT=T+M(1,1)+M(2,1)
620 IFY2+Y1*5+4<R9THEN785
625 PRINT
630 PRINT"YEAR";Y2+Y1*5,"POP= ";
635 IFT<1E6THEN650
640 PRINT INT(T/1E5+.5)/10;" MILLION",
645 GOTO655
650 PRINT INT(T+.5),
655 PRINT"FERTILITY";B2
660 LETF=0
665 IFT*(R-1)=0THEN760
670 IFR<>3THEN690
675 PRINTTAB(25);"PCT. TOTAL POP."
680 PRINTTAB(10);"0.........5........10........15.......20"
685 GOTO695
690 PRINT" AGES";TAB(9);"FEMALES <-MILLIONS-> MALES"," PCT. TOTAL"
695 FORN=1TO16
700 IFN=16THEN715
705 PRINT(N-1)*5;"-";N*5-1;
710 GOTO725
715 IFR=3THEN745
720 PRINT" 75 AND OVER";
725 IFR=3THEN750
730 PRINTTAB(14);INT(M(1,N)/1E5)/10,INT(M(2,N)/1E5)/10,
735 PRINTINT((M(1,N)+M(2,N))*1000/T)/10
740 GOTO755
745 PRINT" 75+";
750 PRINTTAB(10);".";TAB(10+200*(M(1,N)+M(2,N))/T);"*"
755 NEXTN
760 IF F1=1THEN790
765 PRINT"YEAR FOR NEXT REPORT";
```

```
770 INPUT R9
775 IF Y2+Y1*5<R9 THEN790
778 PRINT"YEAR MUST BE GREATER THAN";Y2+Y1*5
780 GOTO765
785 REM YEAR COUNTER
790 LET Y1=Y1+1
795 LETB1=B2
800 GOTO 390
805 PRINT
810 PRINT"WHAT DO YOU WANT TO CHANGE?"
815 PRINT"1-FERTILITY, 2-BIRTH DISTRIBUTION, 3-SEX RATIO"
820 PRINT"4-MORTALITY, 5- POPULATION";
825 INPUTQ
830 IFINT(ABS(Q))<>QTHEN815
835 IFABS(Q-3)>2THEN815
840 IFQ>1THEN850
845 GOTO885
850 IFQ>2THEN860
855 GOTO1010
860 IFQ>3THEN870
865 GOTO985
870 IFQ>4THEN1120
875 GOTO1085
880 IFQ=1THEN910
885 PRINT"FERTILITY IN";Y2+Y1*5;
890 IFY1=0THEN900
895 LETF2=1
900 INPUTB2
905 IFB2<0THEN885
910 PRINT"WILL FERTILITY (1) STAY AT";B2;" OR (2) CHANGE SLOWLY"
915 PRINT"TO A NEW LEVEL";
920 INPUTZ
925 IF(Z-1)*(Z-2)<>0THEN910
930 IFZ<>2THEN980
935 PRINT"WHAT FERTILITY WILL BE STABLE";
940 INPUTB3
945 IFB3<0THEN935
950 PRINT"HOW MANY DECADES UNTIL FERTILITY REACHES";B3;
955 INPUTY3
960 IFY3<=0THEN950
965 IFY3*2<>INT(Y3*2)THEN950
970 LETJ=(B3-B2)/(Y3*2)
975 LETY3=Y3*2+Y1
980 RETURN
985 PRINT"PERCENT FEMALE BIRTHS";
990 INPUTM
995 LETM=1-M/100
```

```
1000 IFABS(M-.5)>.5THEN985
1005 RETURN
1010 PRINT"PCT. FERTILITY OCCURING IN FEMALES AGES:"
1015 LETT=0
1020 FORN=3TO10
1025 IFN=10 THEN 1040
1030 PRINT(N-1)*5;"-";N*5-1;
1035 GOTO1045
1040 PRINT" 45 AND OLDER";
1045 INPUTB(N)
1050 LETB(N)=B(N)/100
1055 LETT=T+B(N)
1060 NEXTN
1065 IFABS(T-1)<.02THEN1080
1070 PRINT"TOTAL MUST BE 100"
1075 GOTO1015
1080 RETURN
1085 LETI=3
1090 PRINT"CHANGE IN MORTALITY OCCURING IN FEMALES"
1095 GOSUB1145
1100 LETI=4
1105 PRINT"CHANGE IN MORTALITY OCCURING IN MALES"
1110 GOSUB 1145
1115 RETURN
1120 LETI=1
1125 PRINT"CHANGE IN FEMALE POPULATION"
1130 GOSUB 1145
1135 LETI=2
1140 PRINT"CHANGE IN MALE POPULATION"
1145 PRINT"GROUPS (FROM AGE, TO AGE)";
1150 INPUTQ,Q1
1155 IFQ=Q1THEN1315
1160 LETQ=INT(Q/5)+1
1165 LETQ1=INT(Q1/5)+1
1170 IFQ1<QTHEN1145
1175 IFQ<1THEN1145
1180 IFQ1<16THEN1190
1185 LETQ1=16
1190 PRINT"GROUP","CURRENT","NEW VALUE"
1195 IF I<3 THEN 1210
1200 PRINT" ","DEATH/1000"
1205 GOTO 1215
1210 PRINTTAB(9);"POPULATION MILLIONS"
1215 FORN=QTOQ1
1220 IFN=16THEN1235
1225 PRINT(N-1)*5;"-";N*5-1,
1230 GOTO1240
1235 PRINT"75 AND OVER",
1240 IF I<3 THEN 1255
1245 PRINT1000-INT(M(I,N)*1E4+.5)/10," ";
1250 GOTO 1260
1255 PRINT INT(M(I,N)/1E5+.5)/10," ";
1260 INPUT Z2
1265 IFI>2THEN1285
1270 IFZ2<0THEN1220
1275 LETM(I,N)=Z2*1E6
1280 GOTO1310
1285 LET M(I,N)=1-Z2/1E3
1290 IFM(I,N)<=1THEN1300
1295 LETM(I,N)=1
1300 IFM(I,N)>=0THEN1310
1305 LETM(I,N)=0
1310 NEXTN
1315 RETURN
1320 DATA2.45
1325 DATA.002,.143,.338,.285,.147,.066,.018,.001
1330 DATA.515
1335 DATA8.430E6,9.749E6,10.209E6,9.492E6,8.531E6,6.931E6
1340 DATA5.834E6,5.703E6,6.116E6,6.293E6,5.747E6,5.221E6
1345 DATA4.612E6,3.756E6,3.263E6,4.697E6
1350 REM - MALE POPULATION FIGURES
1355 DATA8.753E6,10.127E6,10.596E6,9.793E6,8.645E6,6.827E6
1360 DATA5.686E6,5.505E6,5.802E6,5.917E6,5.312E6,4.771E6
1365 DATA4.044E6,3.075E6,2.372E6,2.994E6
1370 REM FEMALE MORTALITY 5 YEAR SURVIVAL RATES
1375 DATA.982188,.997241,.998528,.997810,.996649,.996013
1380 DATA.994799,.992589,.988883,.983307,.975232
1385 DATA.965217,.948579,.921060,.878601,.662675
1390 REM MALE MORTALITY
1395 DATA.977536,.996465,.997803,.995070,.990384
1400 DATA.989478,.989692,.987119,.981037,.970752,.954883
1405 DATA.930882,.893099,.843550,.779330,.590070
1410 PRINT
1415 PRINT "ANOTHER PROJECTION (1=YES, 0=NO)";
1420 INPUT Q
1425 IFQ=1THEN125
1430 END
```

## E. Program Variables

This partial listing includes only the most important variables.

| Program Symbol | Formula Symbol | Meaning |
|---|---|---|
| B | $f$ | Fertility |
| B(N) | $D_i$ | % Fertility expressed in each cohort |
| I | | Index for M(I,N) |
| I9 | | Net immigration |
| M | $m$ | % Male births |
| M(1,N) | $F_i$ | Female cohort population |
| M(2,N) | $M_i$ | Male cohort populations |
| M(3,N) | $S_i$ | Female cohort survival* |
| M(4,N) | $T_i$ | Male cohort survival* |
| N | $i$ | Cohort index |
| Q | $B$ | Births |
| R | | Report format |
| T | $T$ | Total population |
| Y1 | | Year counter |
| Y2 | | Year at start of projection |

---

*Within the program, survival rather than mortality rates are used.

## F. Altering *USPOP*

1) Elimination of immigration is required if you are to model regional populations. Also this effect is desirable for ZPG studies, as most zero population growth studies ignore immigration.

   To eliminate immigration, delete the following lines from *USPOP* before running the program:

   520 565
   525 570
   550 580
   555

2) Updating *USPOP* can be carried out whenever new data becomes available from the Bureau of the Census but since *USPOP* examines population only in 5-year intervals, it is suggested that the first update be made for 1975. After one updating, the new figures become the standard fertility, birth distribution, mortality, and population size.

   All the required data is available through the Department of Commerce, Bureau of Census Publication: *CURRENT POPULATION REPORTS, PROJECTION OF THE POPULATION OF THE UNITED STATES BY AGE AND SEX*. The current series is P-25.

   a) Fertility - the fertility used in *USPOP* is total fertility. This number is stored in line number 1320. To update, replace the old number with the more current fertility.

   b) Birth distribution is obtained by totalling the age specific fertilities and then dividing each age specific fertility by the total. To update, replace the numbers in line 1325. The division product of ages 10-14 is written first, and that of ages 45-50 is last. Each number must be separated by a comma.

   c) Sex ratio - the per cent of male live births is stored in line 1330 in decimal form. To update, just replace the old number with the new one.

   d) Populations

      i) Female - the populations of the 5-year age categories: 0 to 4, 5 to 9, ...... 70 to 75, and 75 and over are stored in lines 1335, 1340, and 1345. The population of females 0 to 4 is stored first, and the population of those females 75 and over is stored last.

ii) Male - the populations of the male 5-year age categories are similarly stored in lines 1355, 1360, and 1365.

To update populations, replace each old number with its new equivalent.

e) Mortality - *USPOP* uses 5-year survival rates rather than 5-year mortality rates to figure the program as "Five-year Survival Rates for the Total Population by Sex."

i) Female - this information is stored in lines 1375, 1380, and 1385; the youngest category first (0 to 4) and the oldest category (75 and over) last.

ii) Male - survival rates are stored in lines 1395, 1400, and 1405 in a similar fashion.

To update mortality, replace each old value with its new equivalent.

## V. ADDITIONAL STUDENT PROJECTS USING *USPOP*

Before attempting these projects, you would be well advised first to carry out at least one of the experiments found in the *USPOP* *STUDENT MANUAL*. The projects described here require considerable skill in framing an experiment and in carrying the experiment out. The skills and experiences gained in performing the experiments in the *STUDENT MANUAL* will definitely be an aid.

Very little in the way of procedure will be indicated for these projects. As an investigation, you should attempt to discover your own method of solution whenever possible.

### *PROJECT 1* AN INVESTIGATION OF ZERO POPULATION GROWTH.

Zero population growth (ZPG) is a movement that has been attracting much attention in the news media lately. Advocates of this movement maintain that the United States should reduce its fertility to slightly above 2 children per woman. (The actual number must be slightly more than 2 to account for female mortality before reaching childrearing ages.)

For your investigation, you can make the following assumptions:

1) Birth distribution, sex ratio of offspring, mortalities and populations remain unchanged throughout the entire time period of the investigation.

2) The downward trend in fertility starts in the year 1970, but the desired fertility is not reached until some time later. When ZPG is achieved, fertility stabilizes; that is, once the fertility falls to 2.0, it stays there.

3) The fertility in the year 1970 is 2.45. (If you answer "yes" to the question "DO YOU ASSUME STANDARD FERTILITY?", you will automatically be given a 1970 fertility of 2.45.)

The problem that you must investigate is:

> GIVEN THE ABOVE ASSUMPTIONS, WHAT PATTERN OF GROWTH IN THE UNITED STATES WILL BE EXPECTED SHOULD ZPG BE ATTAINED IN 1980? 1985? 1990? 1995? or 2000? IN WHAT YEARS CAN WE EXPECT A LEVELING OFF OF THE POPULATION? IS IT OF MAJOR IMPORTANCE THAT WE GO TO ZPG?

All your answers should be carefully documented with results from your computer runs. (Remember *USPOP* assumes 2 million immigrants for each 5-year period. If you wish to subtract them, see Section IV, Part F.)

## *PROJECT 2* AN INVESTIGATION OF POPULATION MAINTENANCE.

If you carried out *PROJECT 1*, you probably found that even if we were to reach ZPG immediately, the population would continue to grow for quite a long time. Demographers have been concerned about this, not so much for the U. S., but for other countries where this continued growth may prove disastrous; so they have used computer models similar to *USPOP* to investigate what changes in fertility would be necessary to maintain population at current levels. In this project, you are to devise a program that will keep population at 1970 levels as closely as possible, by adjusting the fertility as often as necessary.

You can make the following assumptions:

1) Birth distribution, sex ratio of offspring, mortalities and populations remain unchanged during the entire period of the investigation.

2) Fertility in the year 1970 is 2.45.

3) You, as planner, have total control over fertility.

The problem that you must investigate is:

> WHAT CHANGES IN FERTILITY MUST BE MADE BETWEEN 1970 AND 2050 IF THE U. S. IS TO MAINTAIN A CONSTANT POPULATION?

Finding a solution may require many runs; keeping very careful records of which approach worked and which didn't would probably pay off. You may find it easiest to work on a single 10-year period at a time.

## *PROJECT 3* A COMPLEX PROJECTION OF FUTURE POPULATION GROWTH.

In all past simulations you have been restricted to varying only one factor at a time. In this simulation you are free to vary any and all factors over the entire period of projection. The one major restriction is that you must attempt to be as realistic as possible; you must change variables in a realistic way, realistic both to you and to authorities in the field of population planning.

You can begin designing your projection by first plotting out what changes are likely to occur, and when. To help you do this, first read over the introductory section of the *STUDENT MANUAL* and record your thoughts as to the likelihood of each of the events. After you have formed your own opinions, consult at least one of the texts or articles in the SUPPLEMENTARY READINGS section of this Manual, to check your opinions against those of an expert. You may then alter your projection or match your projection against the expert's.

Your only restrictions are to:

1) Assume that the 1970 data is valid for 1970.

2) Be prepared to defend each of your assumptions.

## VI. SUPPLEMENTARY READINGS AND FILMS

### BOOKS

Erlich, Paul R.
*THE POPULATION BOMB*
Ballantine Books, New York, 1968

The widely read plea of a scientist, likened by many to a 20th century Malthus.

MacArthur, Robert and Connell, Joseph
*THE BIOLOGY OF POPULATIONS*
John Wiley and Sons, Inc., New York, 1966

Although concerned primarily with animal populations, the authors do use human examples throughout the text. A mathematical treatment is used.

Malthus, Thomas Robert (1766-1834)
*FIRST ESSAYS ON POPULATION*
Macmillan, New York, 1966

Facsimile reprinting of a Malthus work originally published in 1789.

Malthus, Thomas Robert (1766-1834)
*ON POPULATION*
Modern Library, New York, 1960

Reprinting of Malthus' most famous essay.

Meadows, Dennis L. et al
*LIMITS TO GROWTH*
Potomac Associates, Universe Books, New York, 1972

Highly controversial analysis of future growth, based on computer projections.

Taylor, Gordon Rattray
*THE BIOLOGICAL TIME BOMB*
Signet Edition (paperbound), New American Library, New York, 1968

Lively, stimulating and speculative treatment of the changes that technology and science can be expected to make in man before the year 2000. Subjects discussed include: choice of sex in offspring; fertility control; cryogenics; human genetic engineering; creation of life; and many other areas of high student interest.

## COLLECTIONS OF ESSAYS AND/OR REPORTS

*THE ECOLOGY OF MAN: AN ECOSYSTEM APPROACH*
Edited by Robert Leo Smith
Harper and Row, New York, 1972

Part IV of this paperbound book deals with human population problems. Editor gives a simple mathematical explanation; commentaries from others working in the field follow. Most commentaries are non-mathematical. Nicely balanced readings for the student.

*THE POPULATION DILEMMA*
Edited by Philip M. Hauser
Prentice-Hall, Englewood Cliffs, N. J., 1963

Collection of papers designed for the general reader.

*SYMPOSIA ON QUANTITATIVE BIOLOGY*, Vol.XXII, 1967
Biological Laboratory, Cold Spring Harbor, New York

Series of scientific articles concerned with many aspects of demography. Those dealing with human population are easy to read and require little mathematical skill. Good source of readings for the advanced student. (Many of the interpretations of the scientists can be tested by using *USPOP*.)

## UNITED NATIONS AND UNITED STATES GOVERNMENT PUBLICATIONS

United Nations Department of Economic and Social Affairs
*WORLD POPULATION SITUATION IN 1970*
United Nations Sales Section ($2.00), New York 1971

Bureau of Census
*COUNTY AND CITY DATA BOOK 1967*
U. S. Government Printing Office, Washington, D. C. ($7.75)

Population data for each county and many larger cities within the United States.

Bureau of Census, Current Population Reports Series P-25, No. 454
*INVENTORY OF STATE AND LOCAL AGENCIES PREPARING POPULATION ESTIMATES*
U. S. Government Printing Office, Washington, D. C. (50¢)

This is of special interest to those planning to use *USPOP* for modeling local populations.

Bureau of Census, Current Population Reports Series P-25, No. 493
*PROJECTION OF THE POPULATION OF THE UNITED STATES BY AGE AND SEX*
U. S. Government Printing Office, Washington, D. C., 1972 (35¢)

The latest government projections together with non-technical explanations of assumptions used. Useful for further ideas for using *USPOP*.

Bureau of Census, U. S. Department of Commerce
*STATISTICAL ABSTRACT OF THE UNITED STATES 1971*
U. S. Government Printing Office, Washington, D. C. ($5.50)

An amazing compilation of statistics relevant to most areas of American life. A good source for current information on demographic figures. Published annually. This is the major source used for the data held in *USPOP* data statements.

*CONGRESSIONAL DISTRICT DATA* (for the 92nd Congress)
U. S. Government Printing Office, Washington, D. C.

Individual data available for each state's congressional districts. The cost is 25¢ per state, except for New York and California: 50¢. Excellent source of information for those teachers wishing to model their local areas with *USPOP*.

Department of Health, Education and Welfare
*LEADING COMPONENTS OF UPTURN IN MORTALITY FOR MEN, UNITED STATES, 1952-1967*
DHEW Publication No. (HSM) 72-1008
U. S. Government Printing Office, Washington, D. C. (50¢)

Statistical data and text exploring reasons for the upturn in mortality in men. (The U. S. was one of only three countries in the world that has shown an upturn for male mortality during this period.)

*HISTORICAL STATISTICS OF THE UNITED STATES: COLONIAL TIMES TO 1957;*
Continuation to 1962 and Revisions.
U. S. Government Printing Office, Washington, D. C., 1965 ($1.50)

Good investment for social studies teachers interested in exploring a historical approach to population projection.

U. S. Agency for International Development (A.I.D.)
*POPULATION PROGRAM ASSISTANCE*
U. S. Government Printing Office, Washington, D. C., 1971 ($2.00)

Review of population control programs in each country receiving U. S. assistance.

*REPORT OF THE U. S. COMMISSION ON POPULATION GROWTH AND THE AMERICAN FUTURE*
Available from:
New American Library, New York
or
U. S. Government Printing Office, Washington, D. C.

Details of findings relevant to all aspects of American life.

## ARTICLES FROM POPULAR PUBLICATIONS 1972

"Crucial Math of Motherhood"
*LIFE* 72: p.46-50, 5/19/72.

"Conservative Reacts: Elements of Population Policy"
W. Petersen, *NATIONAL REVIEW* 24: p.520-1, 5/12/72.

"Falling Fertility Rates"
*NEWSWEEK* 79: p.75, 6/19/72.

"Where Does the Planet Go From Here?"
*NEWSWEEK* 79: p.54-5, 6/12/72.

"Population: The U. S. Problem, the World Crisis"
Supplement to *THE NEW YORK TIMES*, 4/30/72.

Contains statements by world leaders concerning population growth. Included are Richard M. Nixon; Martin Luther King, Jr.; Theodore Hesburgh; Kurt Waldheim and others.

"A Woman Anthropologist Offers a Solution to the Woman Problem"
*THE NEW YORK TIMES MAGAZINE*, 8/27/72, p.7.

Uses demographic information to analyze change in female attitude.

"Free Abortion for All?"
*TIME* 99: p.71, 3/27/72.

Reaction to U. S. Commission on Population Growth Report.

"Ways to Cut the U. S. Birthrate, Findings of an Official Study"
*U. S. NEWS AND WORLD REPORT* 72: p.64, 3/27/72.

"What Birthrate Means to the America of Year 2000"
*U. S. NEWS AND WORLD REPORT* 72: p.45-6, 3/20/72.

"Where Will Americans Live in 1990?"
*U. S. NEWS AND WORLD REPORT* 72: p.36-7, 4/10/72.

## SELECTED AUDIO-VISUAL

### 16mm Film Sound

*PEOPLE BY THE BILLIONS*
National Film Board of Canada, 1960
29 Minutes

### Filmstrips 35mm

*CRISIS OF THE ENVIRONMENT*
The New York Times Office of Educational Activities, 1969
Set of 5 filmstrips with sound

*POPULATION EXPLOSION*
The New York Times Office of Educational Activities, 1967